MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2019/2020

EMF3066 – ANTENNA AND PROPAGATION
(TE)

9 March 2020
9:00 A.M. – 11:00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 4 pages with 5 Questions only.
2. Attempt **ALL FIVE** questions.
3. Please print all your answers in the Answer Booklet provided.

Question 1

(a) The radiation intensity of an antenna is given by:

$$U(\theta, \emptyset) = U_m \sin\theta$$

Calculate the directivity in this case. Note that U_m is the maximum radiation intensity and $(\theta, \emptyset)$ is the spherical coordinate system.

[10 marks]

(b) Give the definition of the following terms as applied to antennas:

(i) Half-power beamwidth
(ii) Directivity
(iii) Gain
(iv) Radiation intensity
(v) Radiation resistance

[10 marks]

Question 2

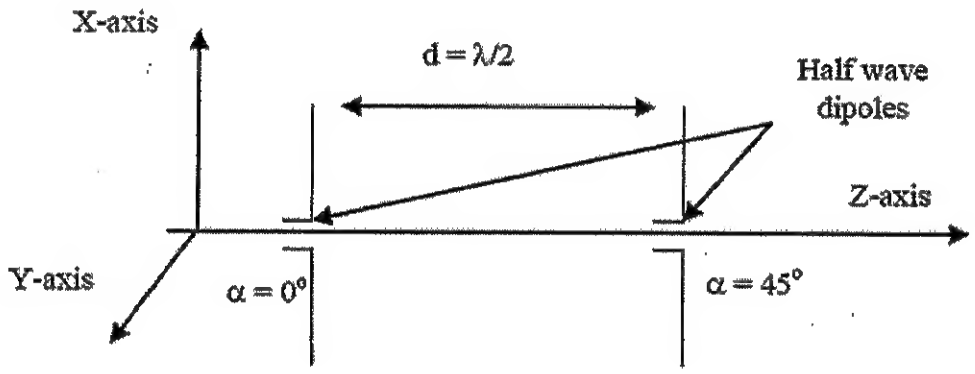

Figure Q2

An array is constructed with two half-wave dipoles spaced half-wavelength apart (d=$\lambda/2$). The dipoles are arranged along the Z-axis, with the dipole oriented parallel to the X-axis, as shown in Figure Q2. The dipoles are fed with equal power and have a progressive phase shift (α) of 45° between elements.

(a) Determine the array factor for this arrangement.

[6 marks]

(b) Calculate the pattern nulls and pattern maximum for this array.

[6 marks]

(c) Sketch the total pattern. [8 marks]

Continued .....

Question 3

(a) With the help of a diagram, explain the construction and operation of a Yagi-Uda antenna.

[11 marks]

(b) Based on the definition of smart antenna, one can define "levels of Intelligence". Name three types of "levels of Intelligence" and explain them with the aid of diagrams.

[9 marks]

Question 4

(a) With the aid of diagram, illustrate the FIVE (5) layers found in the earth's atmosphere.

[7 marks]

(b) In a free-space propagation of radio wave, state the propagation mechanisms that can affect it.

[5 marks]

(c) Given that a transmitting antenna has a gain of 50 dBi and radiates at 15 W at a frequency of 8 GHz. Find the received power at a distance of 20 km if similar antenna is used as receiving antenna.

[8 marks]

Question 5

(a) Derive an expression for the Doppler frequency shift, f_d of an opening target (target motion is away from radar) in terms of radar-target velocity, v and wavelength λ.

[9 marks]

(b) In a pulse radar with pulse repetition frequency (PRF) of 300Hz, determine the following:

(i) Maximum unambiguous range.
(ii) Corresponding inter pulse period (IPP).

[4 marks]

Continued .....

(c) A tracking radar system that operates at 3.0 GHz is capable of detecting objects up to 150 km away. The radar transmitter has a peak pulse power of 2.0 MW. The receiver sensitivity of the radar is 0.3 pW. A paraboloid antenna with a diameter of 2.4 m and an efficiency of 75 % is used in the radar. The atmospheric losses is 0.01dB/100km. What is the smallest radar cross-section of an object that can be detected by this radar?

[7 marks]

Appendix – Useful Formulas

Physical Constants and Units

Constant	Symbol	Value (mks units)
Speed of light in vacuum	c	3×10^{8} m/s
Electron charge	q	1.602×10^{-19} C
Boltzmann's constant	k_B	1.38×10^{-23} J/K
Permittivity of free space	ε_0	8.8542×10^{-12} F/m
Permeability of free space	μ_0	$4\pi \times 10^{-7}$ N/A^2
Electron volt	eV	1 eV = 1.602×10^{-19} J
Planck's constant	h	6.626×10^{-34}J·s
Electron rest mass	m	9.11×10^{-31} kg
Effective electron mass	m_e	$0.068m$
Effective hole mass	m_h	$0.56m$

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